(For the use of the Department only)

Tests
D-2
Chem. 30
Supp. 1966

EDUCATION LIBRARY
UNIVERSITY OF ALBERTA

HIGH SCHOOL AND UNIVERSITY MATRICULATION

EXAMINATIONS BOARD

DEPARTMENTAL EXAMINATIONS, 1966

SUPPLEMENTAL

8

CHEMISTRY 30

Time — 3 hours.

DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.
READ THE DIRECTIONS FOR EACH QUESTION CAREFULLY.

Total Possible Mark — 260.

All your work must be done in this booklet.
Do not write your name on this booklet.

Mathematical tables may be used.
Slide rules are permitted.

Page 2A contains the Periodic Table. This page, for convenience, should be torn along the perforations for ready reference when required.

Rough work and diagrams may be done in pencil.
Finished work must be done in ink (blue or black).

IN SOLUTIONS TO PROBLEMS ENOUGH WORK MUST BE SHOWN TO INDICATE THE METHOD USED. Give numerical answers to three significant digits unless otherwise indicated. Include units.

DO NOT FOLD THE BOOKLET.

Place your test booklet in the answer envelope in such a way that the **UPPER LEFT HAND CORNER OF THE BOOKLET** (Candidate's Number) shows through the **SLASHED CORNER** of the answer envelope.

BE SURE TO SEAL THE ENVELOPE.

USE THE ATOMIC WEIGHTS SHOWN IN THE PERIODIC TABLE.

Gas Constant, R = 0.0821 liters-atmospheres per degree-mole.

LB
3054
C2
D419
1966a
chem.30

CURR HIST

(For the use of Sub-Examiners only)

Values

Place the NUMBER corresponding to the best answer in the brackets to the right. Each correct answer has a value of 2 marks for questions 1 to 25 inclusive.

1. One formula unit of the salt Na_2SO_4 contains
(1) 1 atom of sulfur
(2) 1 mole of sodium
(3) 1 gram of sulfur
(4) 111 grams of Na_2SO_4 (..................)

2. Energy is released when a substance dissolves in water and the
(1) hydration energy is negative
(2) lattice energy is negative
(3) hydration energy is greater than the lattice energy
(4) lattice energy is positive (..................)

3. Of the following elements, which should have the lowest ionization potential?
(1) Ne
(2) O
(3) C
(4) Na (..................)

4. An example of a secondary amine is
(1) $(C_2H_5)_2NH$
(2) $C_2H_5NH_2$
(3) $(C_2H_5)_3N$
(4) $(C_2H_5)_4N^+$ (..................)

5. Gamma rays are
(1) high energy electrons
(2) low energy electrons
(3) high energy electromagnetic waves
(4) high energy positrons (..................)

6. The time ratio of diffusion of a volume of oxygen into an equal volume of hydrogen both under the same conditions of temperature and pressure is
(1) $\frac{1}{16}$
(2) $\frac{1}{4}$
(3) 16
(4) 4 (..................)

FOR ROUGH WORK

(No marks given for work in this space)

Page 2A

Tear this page out for ready reference when required.

PERIODIC TABLE

GROUP — TRANSITION ELEMENTS GROUP — GROUP

PERIOD	1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	GROUP 0
1											1 H 1.0							2 He 4.0
2	3 Li 6.9	4 Be 9.0											5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.2
3	11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
4	19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
5	37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc ---	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57-71 See La Series	72 Hf 178.5	73 Ta 181.0	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (210)	85 At ---	86 Rn (222)
7	87 Fr ---	88 Ra 226.0	89-103 See Ac Series															

La Series	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm ---	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Ac Series	89 Ac (227)	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np —	94 Pu —	95 Am —	96 Cm —	97 Bk —	98 Cf —	99 Es —	100 Fm —	101 Md —	102 No —	103 Lw —

LIBRARY
UNIVERSITY OF ALBERTA

7. In a metallic solid the points of the space lattice are occupied by
(1) positive ions
(2) electrons
(3) negative ions
(4) positive and negative ions
(..................)

8. 6.02×10^{23} atoms of tin weigh
(1) 118.7 gram-atoms
(2) 118.7 grams
(3) 1 gram-atom
(4) 32 atomic mass units
(..................)

9. Choose the correct formula for methyl acetate
(1) $C_2H_5COOH_3$
(2) $CH_3COOC_2H_5$
(3) CH_3COOCH_3
(4) $C_2H_5COOC_2H_5$
(..................)

10. The compound which does not contain the peroxide ion is
(1) Na_2O_2
(2) BaO_2
(3) SnO_2
(4) H_2O_2
(..................)

11. One molecule of HBr
(1) contains one gram-atom of hydrogen
(2) weighs 80.9 atomic mass units
(3) occupies 22.4 liters at STP
(4) is one mole of HBr
(..................)

12. Which of the following contains two pairs of unshared valence electrons?
(1) NH_3
(2) NH_4^+
(3) CH_4
(4) H_2O
(..................)

FOR ROUGH WORK
(No marks given for work in this space)

13. The density of methane gas, CH_4, at 2.00 atmospheres and 27° C. is
(1) 26.0 grams/liter
(2) 0.260 grams/liter
(3) 1.30 grams/liter
(4) 0.130 grams/liter (.................)

14. In the electrolysis of NaCl solution, the reduction that takes place at the cathode is
(1) $2H^+ + 2e^- \longrightarrow H_2$
(2) $2H_2O + 2e^- \longrightarrow H_2 + 2OH^-$
(3) $Na^+ + e^- \longrightarrow Na$
(4) $2Cl^- \longrightarrow Cl_2 + 2e^-$ (.................)

15. In general, going from right to left across the periodic table, the radii of atoms
(1) decrease
(2) remain unchanged
(3) increase
(4) have no set pattern (.................)

16. Which of these has a zero mass?
(1) a proton
(2) an alpha particle
(3) a beta ray
(4) a gamma ray (.................)

17. The number of isomers of C_5H_{12} is
(1) 2
(2) 3
(3) 4
(4) 5 (.................)

18. A Faraday of electricity can be considered as
(1) one ampere/second
(2) 96,500 coulombs/second
(3) 6.02×10^{23} electrons/second
(4) 6.02×10^{23} electronic charges (.................)

19. One mole of H_2S gas contains
(1) 2 atoms of hydrogen
(2) 2 molecules of H_2S
(3) 2 gram-atoms of hydrogen
(4) 1 gram of hydrogen (.................)

FOR ROUGH WORK

(No marks given for work in this space)

20. Each carbon atom in the diamond lattice is bonded covalently to

(1) two other carbon atoms
(2) four other carbon atoms
(3) six other carbon atoms
(4) eight other carbon atoms (..................)

21. A product formed by the reaction of sodium with ethanol has the formula

(1) H_2O
(2) NaOH
(3) NaH
(4) H_2 (..................)

22. An element with an odd atomic number is always

(1) ferromagnetic
(2) diamagnetic
(3) paramagnetic
(4) polarmagnetic (..................)

23. The oxidation number of element "X" in $HX_2O_7^-$ is

(1) +4
(2) $+6\frac{1}{2}$
(3) O
(4) +6

24. The formula of an unsaturated hydrocarbon is one of the following:

(1) C_2H_2
(2) C_2H_6
(3) C_3H_8
(4) C_4H_{10} (..................)

25. Non-polar compounds would be expected to

(1) conduct an electric current
(2) have low solubility in water
(3) dissolve readily in polar solvents
(4) have a strong attraction for electrons (..................)

FOR ROUGH WORK

(No marks given for work in this space)

Values

15 **26.** Complete each of the following statements by writing an appropriate answer in the space provided.

(a) Usually ionization potential is expressed in units of ....

(b) Acids which furnish two or more protons per molecule are termed ....

(c) That the products resulting from a chemical reaction have the same mass as the reactants is a statement of the Law of ....

(d) Sodium forms two different oxides. This illustrates the Law of ....

(e) The extent of dissociation of an acid with two or more atoms of hydrogen per molecule is governed by ....

(f) The shape of the ammonia molecule is ....

(g) When the molecules of a solute in a solvent retain their identity, the solution is known as a/an ....

(h) In the expression, $PV = n R T$, "n" refers to ....

(i) The dipole moment of a molecule is obtained by finding the ....

(j) An increase in oxidation number is called ....

(k) 0.000803 expressed as a power of 10 is ....

(l) Of the two elements, potassium and fluorine, the element with the lower ionization potential is ....

(m) Of the two elements, lithium and chlorine, the element with the greater electronegativity is ....

Values

(n) The functional group that identifies an organic acid is called the ....

(o) The reaction between an acid and an alcohol is called ....

FOR ROUGH WORK

(No marks given for work in this space)

Values

12 **27.** Write the electron-dot formula (electronic formula) of each of the following ions or molecules:

Example: water $\begin{array}{cccc} & \cdot\cdot & & \\ : & \text{O} & : & \text{H} \\ & \cdot\cdot & & \\ & \text{H} & & \end{array}$

(a) NH_4^+

(b) CO_2

(c) Br^{-1}

(d) Cl_2

(e) H_2SO_3

(f) H_2O_2

3 **28.** Atoms X, Y, and Z occur in Period 3 and have 2, 6 and 7 valence electrons respectively. Write the electronic formula for the compound most probably formed between X and Z. Name the bond formed.

DIAGRAM	NAME OF BOND
	....

FOR ROUGH WORK
(No marks given for work in this space)

Do Not
Write in
This Space

Values

9 **29.** Explain the difference between the following pairs:

(a) A strong acid and a concentrated acid.

(b) Electrolytic conductors of electric current and metallic conductors of electric current.

(c) A mole and a molecular weight of a compound.

FOR ROUGH WORK

(No marks given for work in this space)

Do Not
Write in
This Space

Values

3 **30.** Describe the effect that a temperature increase has upon the dynamic equilibrium of a quantity of chloroform and air enclosed in a sealed vessel.

....

....

....

....

....

....

7 **31.** Write the CHEMICAL NAME for each of these compounds in the space indicated.

(a) Na_2O_2 ....

(b) $NaBrO_3$ ....

(c) $Ca(HCO_3)_2$ ....

(d) $K_3Fe(CN)_6$ ....

(e) $KHC_8H_4O_4$ ....

(f) $HOCl$ ....

(g) $SO_2(OH)_2$ ....

FOR ROUGH WORK

(No marks given for work in this space)

Do Not
Write in
This Space

Values

10 **32.** Write balanced chemical equations for each of the following:

(a) The decomposition of sodium bicarbonate. Amount of heat required to decompose 1 mole of this substance is 16.5 kcal. Include the heat of reaction as a term of the equation.

....

(b) The dissociation of the monosodium dihydrogen phosphate molecule.

....

(c) The overall cell reaction that occurs in the electrolysis of sodium chloride solution.

....

(d) Bromine water is added to aqueous sodium chloride and shaken vigorously.

....

(e) The NET equation for the reaction between sodium sulfate and barium chloride.

....

FOR ROUGH WORK

(No marks given for work in this space)

Values

4 **33.** (a) Balance the following equation by the use of oxidation numbers. Indicate clearly each step used.

$$K_2Cr_2O_7 + SnCl_2 + HCl \longrightarrow KCl + CrCl_3 + SnCl_4 + H_2O$$

4 (b) Balance the following equation by the half-reaction method. Indicate clearly each step used.

$$NO_2^- + Cr_2O_4^{--} \longrightarrow NO_3^- + Cr^{+3} \qquad \text{(acidic)}$$

4 (c) Balance the following equation by the half-reaction method. Indicate clearly each step used.

$$N_2O_4 + Br^- \longrightarrow NO_2^- + BrO_3^- \qquad \text{(basic)}$$

FOR ROUGH WORK

(No marks given for work in this space)

Do Not
Write in
This Space

Values

6 **34.** An atom of an element has two K electrons, eight L electrons, nine M electrons, and two N electrons. Its atomic weight is 45.

(a) The atomic number of the element is ....

(b) The number of neutrons in the nucleus is ....

(c) The total number of "s" electrons is ....

(d) The charge on the kernel of the element is ....

(e) The total number of "p" electrons is ....

(f) The electronic configuration of the element is

....

2 **35.** (a) What are the two conditions which cause a gas to deviate from ideal behavior?

(1) ....

....

(2) ....

....

2 (b) Explain why each of the conditions listed cause the deviation from ideal behavior.

(1) ....

....

(2) ....

....

FOR ROUGH WORK

(No marks given for work in this space)

Do Not Write in This Space

Values

10 **36.** Select the term which best fits each of the following descriptions and write the NUMBER of the term in the space after each description.

TERMS

(1) ionic bond
(2) polar covalent bond
(3) non-polar covalent bond
(4) dipole moment
(5) ionization
(6) electronegativity
(7) electron affinity
(8) Fraunhofer
(9) atomic volume
(10) saturation of valence
(11) multiple bond
(12) protein molecule
(13) coordinate covalent bond
(14) molecular orbital

DESCRIPTIONS

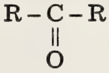
(a) Bonding due to unequal sharing (..................)
(b) Absorption spectra (..................)
(c) The limit to combining ability (..................)
(d) Peptide linkage (..................)
(e) The energy levels that the electrons occupy in the molecule (..................)
(f) Attraction of unlike charged atoms (..................)
(g) The bonding in Cl_2 (..................)
(h) The tendency of an atom to become negative on bond formation (..................)
(i) Sharing of a pair of electrons by two atoms when only one of the atoms supplies the pair of electrons (..................)
(j) A measure of the tendency of a polar molecule to turn when placed in a magnetic field (..................)

FOR ROUGH WORK

(No marks given for work in this space)

Values

12 **37.** (a) Write the GENERAL structural formula for each of the following:

Example: ketone 

$$R-\underset{\underset{O}{\|}}{C}-R$$

(1) Alcohols (2) Aldehydes

(3) Esters (4) Ethers

(5) Amines (6) Alkenes

9 (b) Name each of the following compounds and write their structural formulas:

STRUCTURAL FORMULA

(1) $CH_3COC_2H_5$

....
(Name)

(2) $C_6H_4Cl_2$

....
(Name)

(3) NH_2CH_2COOH

....
(Name)

Values

15 **38.** Explain briefly the FORCES which hold together each of the following:

(a) Oxygen atoms in an oxygen molecule

....

....

....

(b) Helium atoms in liquid helium

....

....

....

(c) Water molecules in liquid water

....

....

....

(d) Silver atoms in solid silver

....

....

....

(e) Sodium and chlorine in solid table salt

....

....

....

FOR ROUGH WORK

(No marks given for work in this space)

Values

12 **39.** Briefly describe the general characteristics of an ATOM MODEL visualized by each of the following scientists.

(a) Thomson

....

....

....

....

(b) Rutherford

....

....

....

....

(c) Bohr

....

....

....

....

(d) Dalton

....

....

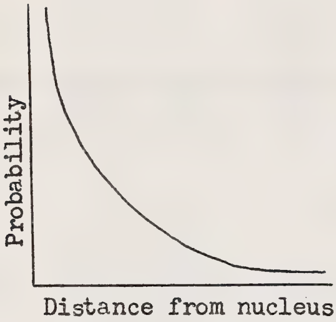
....

....

Values

40. Below are reproduced two graphs of the PROBABILITY DISTRIBUTION of a "ls" electron. Give a brief explanation of the significance of each graph as applied to the electron's probability pattern.

2 (a)



....

....

....

....

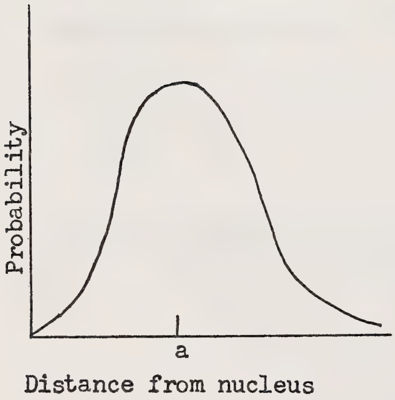
....

....

....

....

2 (b)



....

....

....

....

....

....

Values

4 **41.** Explain the meaning of RESONANCE as it is applied to a molecule of sulfur dioxide (SO_2). Use electronic (dot) diagrams and indicate the use of the octet rule in your explanation.

4 **42.** Discuss OXIDATION-REDUCTION in conjunction with the use of the following simple reaction:

$$Cl_2 + 2KI \longrightarrow 2KCl + I_2$$

In your discussion indicate clearly the electron transfer, substance oxidized and reduced, oxidizing and reducing agents.

Values

4 **43.** What weight of aluminum will be plated in an electrolytic cell by the same current that will electroplate 12 grams of calcium in the same time?

4 **44.** In the synthesis of a compound there are used up 1.26 grams of carbon, 0.240 gram-atoms of hydrogen, and 9.01×10^{21} atoms of oxygen. What is the simplest formula of the compound?

FOR ROUGH WORK

(No marks given for work in this space)

Values

4 **45.** The compositions by weight of two common oxides of sulfur are:

(a) 40.1% S and 59.9% O, and

(b) 50.1% S and 49.9% O.

Show that these oxides conform to the Law of Multiple Proportions.

FOR ROUGH WORK
(No marks given for work in this space)

Do Not
Write in
This Space

Values

4 **46.** If 2.40 grams of oxygen gas and 0.20 grams of hydrogen gas are collected over water in the same container whose volume measures 3.75 liters, calculate the total pressure at 17° C.
(Vapor pressure of water at 17° C. is 14.5 mm. of mercury)

FOR ROUGH WORK

(No marks given for work in this space)

Do Not
Write in
This Space

Values

47. A bottle contains 31.6 grams of a colored compound which consists of 24.7% K, 34.8% Mn, 40.5% O by weight.

6 (a) Calculate the number of gram-atoms of each of the elements present in the bottle.

2 (b) Calculate the total number of atoms of all the elements present in the bottle.

FOR ROUGH WORK

(No marks given for work in this space)

3 **48.** Calculate the average speed of SO_2 molecules at STP, if it is known that the average speed of helium atoms is 1.5×10^3 miles per hour under the same conditions.

7 **49.** In the electrolysis of water, the cathode reaction may be represented by the ionic equation:

$$2H_2O + 2e^- \longrightarrow H_2 + 2\ OH^-$$

If a current of 1.93 amperes flows through the acidified water for one hour and forty minutes, calculate the number of grams of hydrogen gas produced.

FOR ROUGH WORK

(No marks given for work in this space)

Values

3 **50.** To what volume must 300 ml. of a 2M solution of H_3PO_4 be diluted to yield a 1.6 M solution of this acid?

5 **51.** The following balanced chemical equation represents the reaction between vanadium oxide and iron oxide.

$$2VO\ (s) + 3Fe_2O_3 \longrightarrow 6FeO\ (s) + V_2O_5\ (s)$$

How many grams of V_2O_5 can be formed from 2.0 grams of VO and 5.75 grams of Fe_2O_3?

FOR ROUGH WORK

(No marks given for work in this space)

Do Not
Write in
This Space

Values

4 **52.** In a titration experiment, 20.0 ml. of H_2SO_4 solution just neutralized 25.0 ml. of a 2.5 Normal solution of NaOH solution. What is the Molarity of the H_2SO_4 solution?

FOR ROUGH WORK

(No marks given for work in this space)

Do Not
Write in
This Space

Values

53. In your laboratory investigations numerous observations were made. The following questions are based on these observations.

4 (a) When identifying metallic ions by using flame tests, the following colors were observed for particular metallic ions:

	Metallic Ion
violet color	....
emerald green	....
yellow green	....
yellow	....

3 (b) When ammonium hydroxide is added to an aluminum sulfate solution a white, jelly-like precipitate is observed which disappears when excess sodium hydroxide solution is added. Explain without using equations.

....

....

....

....

....

3 (c) After a few drops of 6M HCl solution is added to an unknown solution, a fine white precipitate appears which dissolves on addition of 6M NH_4OH solution. Explain without using equations and identify the unknown cation.

....

....

....

....

3 (d) When 6M HCl solution is added to mercurous nitrate solution a fine white precipitate appears which turns black on the addition of 6M NH_4OH. Explain without using equations.

....

....

....

....

....

TOTAL = $\frac{\qquad}{2}$ =

DATE DUE SLIP

F255

LB 3054 C2 D419 1966A CHEM-30
DEPARTMENTAL EXAMINATIONS GRADE
12 1966 SUPPLEMENTAL --

39780823 CURR HIST

000016283756

LB 3054 C2 D419 1966a chem.30
Departmental examinations,
[grade 12] 1966, supplemental.
-
39780823 CURR HIST